Swift Observations of Cometary UV and X-ray Emission

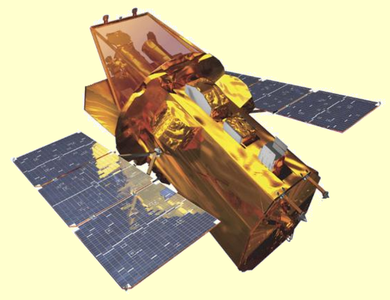
Dennis Bodewits[1,2], Michael J. Mumma[2], Scott Porter[2], Stefan Immler[2], Wayne Landsman[2] and Greg V. Brown[3]

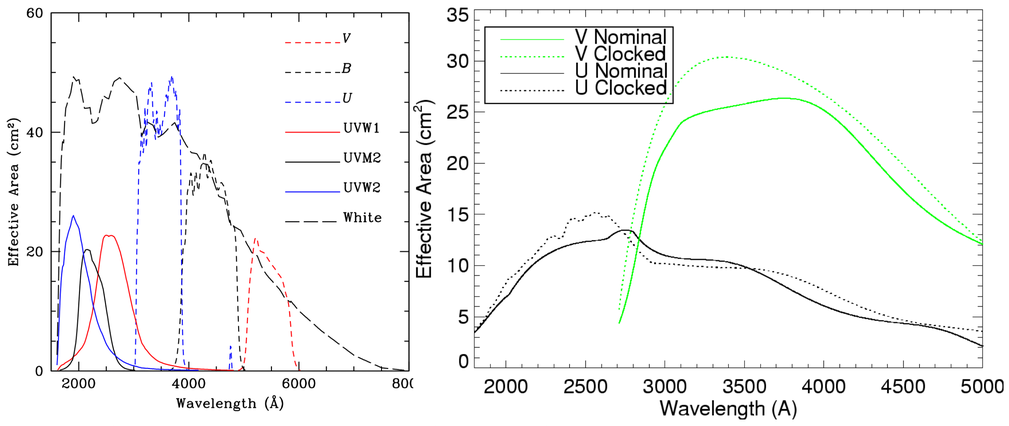
The abundance of native ices in comet nuclei is a fundamental observational constraint in cosmogony. An important unresolved question is the extent to which the composition of pre-cometary ices varied with distance from the young sun. Our fundamental objective is to build a taxonomy based on cometary volatile composition instead of orbital dynamics.

Secondly, the interaction of the solar wind with the planets, moons and the interstellar medium is of key importance for understanding the evolution of our solar system. The interaction with Earth's atmosphere is best known for the northern light. In case of Mars, the interaction with the solar wind might have lead to the erosion of its atmosphere. Solar wind-atmosphere interactions can be studied particularly well in comets, because in that case the solar wind flow is not attenuated by a planetary magnetic field and interacts directly with its atmosphere, the coma.

Swift

Swift is a multi-wavelength space-based observatory is a unique observatory by combining UV/optical and X-ray instruments. Although primarily dedicated to the study of gamma-ray bursts, Swift's multi-wavelength capabilities allows linking the behaviour of comets and the solar wind.

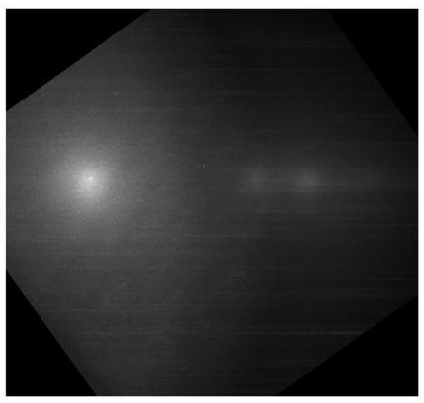


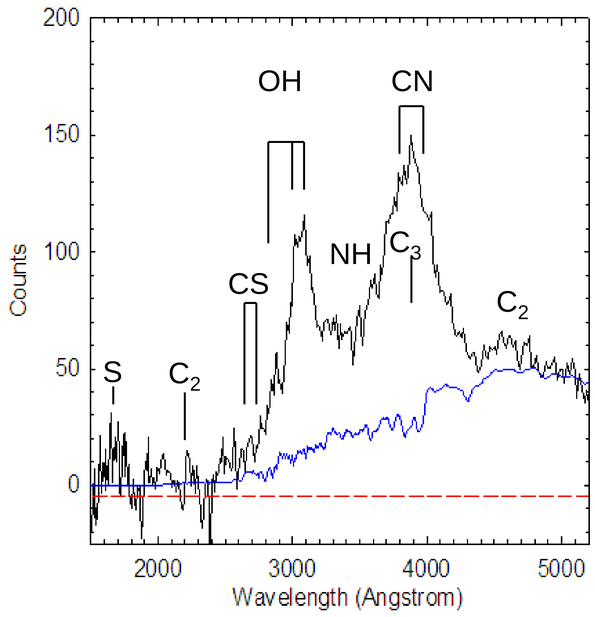


Swift UVOT response matrices. **(Left)** Optical filters **(Right)** Grisms. (Mason et al., 2004)

UV Spectroscopy

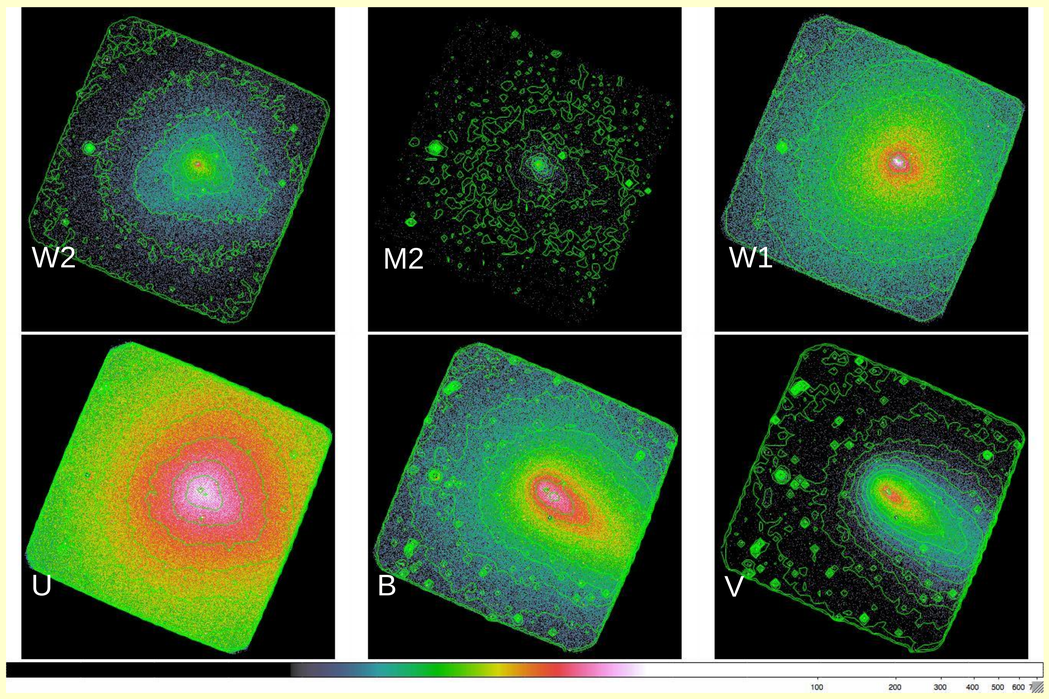
Swift's UV grisms (175-520 nm) encompass known cometary fluorescence bands such as CO_2^+ (280 nm), OH (306 nm) (the principal photolysis product of H_2O), of native CO, and of many other molecular fragments (e.g., NH, CS, CN, fragment CO, etc.) that can quantify and track the water and organic ice chemistry in the coma.





(Above) Grism image of comet 8P/Tuttle. The 0th order, OH and CN features are clearly visible. **(Right)** The extracted UV spectrum of comet 8P/Tuttle observed with the U-grism on board Swift. The solar continuum is shown in blue.

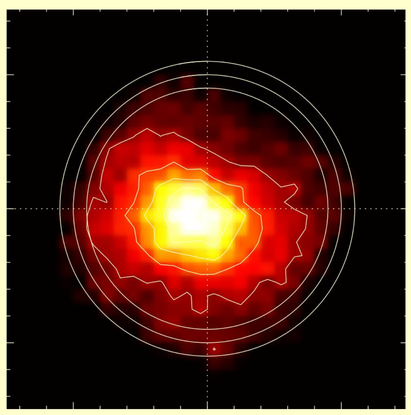
UV and Optical Photometry



Comet 73P/Schwassmann Wachmann C observed with different Swift UVOT filters. Each frame is 17"x17" wide. The images are ordered by color, W2 being the bluest and V the reddest filter. Notice that in the filters that mainly sample gas (OH, W1), the comet appears nearly symmetric, whereas in the B and V filters the dust tail clearly shows up. Photometric studies of comets yield many imporant characteristics of the comet, such as the rotation period of its nucleus and the production rates as well as outflow velocities of gas and dust.

X-Ray

When solar wind ions fly through an atmosphere they are neutralized via charge exchange reactions with the neutral gaseous species. These reactions depend strongly on target species and collision velocity, and the resulting X-rays are a strong diagnostic of local solar wind conditions and of bulk properties of the cometary gas.



Comet 73P/Schwassmann Wachmann observed with Swift's XRT. The image is the sum of multiple observation. (Courtesy of R. Willingale).

1 - Nasa Postdoctoral Fellow, 2 - Goddard Space Flight Center, Greenbelt, MD 20771 USA, 3 - Lawrence Livermore National Lab., Lawrence, CA 94450 USA